# PhD and PostDoc

## Young scientist contract offered by INRA

## Call for applications - March 2013

INRA offer during 2013 one "Contrat Jeune Scientifique" (Young Scientist Contract) for 3 years (duration for completion of a PhD) followed by two years of post doctoral research.

CJS Research Topic 3 offer a position to fill in autumn 2013.

## "Vulnerability and resilience of aquatic ecosystems to qualitative and quantitative changes in allochthonous organic matter inputs coming from forests"

Research will take place in France (PhD) and Ecuador (post doctoral research).

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**Applications**

Applicants to this contract should send the application files including :

- A detailed CV with all details about obtained degrees, fulfilled training and results,
- A motivation letter indicating the concerned topic (Topic 3 : Vulnerability and resilience of aquatic ecosystems to qualitative and quantitative changes in allochthonous organic matter inputs coming from forests") and the plans of the candidate for his/her future career,
- A recommendation letter provided by a professor or a researcher who supervised the candidate during his/her training.

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**Applications files could be sent to Professor Damien BANAS (damien.banas@univ-lorraine.fr) no later than Sunday April 21st**, in order to be processed and eventually improved before to be sent to the Doctoral School.
Next, applications files should be sent to the administration of the Doctoral School (christine.fivet@univ-lorraine.fr) with a copy to the president of INRA – Nancy (presid@nancy.inra.fr) before Wednesday May 15th. A selection committee will examine all applications and will select the candidates for an audition, based on the skills of the candidates and their adequation to the topic. The final selection will follow the audition of the candidates (Beginning of June 2013). Each audition will be based on 15 min presentation followed by 20 min questions. The audition can be organised with a video conferencing system.

For more information, please contact: damien.banas@univ-lorraine.fr

Research Topic 3 :

# "Vulnerability and resilience of aquatic ecosystems to qualitative and quantitative changes in allochthonous organic matter inputs coming from forests"

**General research topic and state of the art:**

*Context:*

Forest and aquatic ecosystems are closely linked. Thus, it is generally assumed that, according to climate, soil and forestry practices, forest tends to improve water quality (Willis, 2002). On the other hand, depending on forestry practices, acidification of water, erosion of soil and quantitative reduction of water available for other uses, are the negative impacts most frequently pointed.

In many aquatic systems located at the head of river basins, the leaves coming from forests are almost the unique source of organic matter (OM) available for aquatic organism growth. There, the trophic web depends on allochthonous inputs and OM recycling is ensured by few organisms constituting simple trophic chains, adapted to this resource. It is assumed that these trophic webs are less resilient than more complex food webs. In these systems, several authors have shown that anthropogenic stressors such as acidification (Dangles et al., 2004), metal contamination (Dukowska et al., 2012) or drought and water level fluctuations (Dolbeth et al., 2011), can dramatically disrupt communities of organisms (*i.e.* aquatic fungi as aquatic hyphomycetes and leaf-shredding macro-invertebrates). When stress continues or increases, it can lead to the disappearance of key species, leading to an insufficient capacity to recycle allochthonous organic matter. Next, even in case of environmental restoration, recovery of benthic assemblage is long and limited (Pye et al., 2012). Thus, the apparent redundancy of functions among species sometimes observed in complex food webs should be considered as a biological guarantee to insure resilience of the ecosystem. This resilience can be particularly useful in the context of global changes that, in forest areas, could result in changes in water availability, productivity and nature of leaves (e.g. C/N ratio) due to changes in forest tree species. These changes will inevitably disrupt aquatic food webs in addition to anthropogenic stressors already mentioned. It appears therefore important to ensure that these ecosystems will be able to adapt to these changes and to determine what will be the conditions favorable to resilience.

Ponds are aquatic systems frequently associated to forests. In these systems, the sources of organic matter may be more diverse than in streams. There, according to seasons, the source of OM can be either allochthonous (e.g. leaf litter and nutrients carried by tributaries or entering directly from the surrounding area) or autochthonous (i.e. phytoplankton or helophytes) (Banas et al., 2002). Ponds and rivers are strongly connected to their watersheds. This connection allows inputs of allochthonous matters and pollutants into ponds (Lazartigues et al., 2012; 2013). Therefore, it also determines the food resources and the stress to which species are exposed. Thus, on a forested watershed, Lazartigues (2010) observed high concentrations of trace metals (lead, especially, but also copper) in some fish species collected in pond. It was shown that during the degradation of organic matter, trace metals associated with organic debris could be mobilized and incorporated by biological organisms through the biofilm and benthic invertebrates (Schaller, 2013). This could have deleterious effects on the trophic chain concerned. It represents also a potential sanitary problem for fish production.

*Hypothesis to test*:
The hypothesis is that, given the multiple food resources in ponds, the diversity of trophic chains ensures to systems, a greater resilience to anthropogenic stresses and changes going on forested watersheds. If this hypothesis was true, the couple pond-forest would be a guarantee of sustainability for water resources within forest ecosystems exposed to global changes and anthropogenic stressors.

*Objectives and methodology:*
This young scientist contract will aim to assess the role of communities of micro-organisms and invertebrates in the decomposition of various litters, to evaluate functional redundancy among species and assess the resilience of communities to quantitative and qualitative changes in inputs of allochthonous organic matter. The study of these processes will require collaborations with research units of the federative research institute IFR110 (Nancy) and other laboratories of the Universities of Lorraine, Toulouse and Quito (Ecuador).
The first objective will be to determine the trophic relationships within various ecosystems (ponds vs. streams) located on forest watershed and to determine the functions of biological organisms constituting the food chains. The first steps will be based on collection and identification of organisms. Trophic relationships will be assessed by analysis of stable isotopes of nitrogen ($_{15}N/_{14}N$) and carbon ($_{13}C/_{12}C$). This will allow us to determine the functional redundancy existing within food webs, to isolate the key species (without redundancy with other species) and to assess the degree of simplification and the fragility of food webs.
The second objective will be to assess the degree of specialization of macro-invertebrates according to the heterogeneity of forests (forest species, productivity, practices of management). To do this, various ponds will be selected based on the forest cover of their watershed. Ponds will be selected in order to present a qualitative (C/N) and quantitative diversity of allochthonous organic matter. By comparison with results obtained in stream, our study will allow us to identify invertebrate taxa adapted to the nature and richness of allochthonous inputs. The degree of divergence between the food webs will provide us estimation of the organism adaptability to qualitative or quantitative changes of forest cover.
Then, from the results obtained in the previous step, we will quantify the ability of microorganisms and invertebrates to adapt to a qualitative and quantitative change of allochthonous matter inputs. For this purpose, litterbags will be used and the decomposition kinetics will be evaluated (Gessner et al., 1993; Dangles et al., 2004). The use of organic matter enriched in stable isotopes will allow us to determine the fate and the utilization of nutrients in the food webs. These results will allow us to determine, for the various taxa, the tolerable magnitude of quantitative and qualitative changes in allochthonous inputs. They will also allow us to assess the distribution of nutrients throughout the aquatic food webs.

*References:*

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**Aims and specific research questions to be addressed by the young scientist:**

The goal of the young researcher will be to determine whether the presence of ponds on a forest stream can increase the resilience of aquatic systems to changing forest cover, induced by global change. To achieve this goal, the young researcher will determine the ability of pond communities (microorganisms and invertebrates) to decompose litter, and compare these results to those observed in streams. Various scenarios of changes in litter inputs to aquatic environments will be simulated. These will need to take into account qualitative changes (e.g. C/N ratio; due to changes in forest species), and quantitative changes related to changes in tree growth or intensification of exploitation.

**Novelty and importance for the research team:**

The DAC research team has been studying since several years interactions between ponds and watershed management. These studies take into account the flow of water, nutrients and contaminants. Interactions between aquatic organisms, and consequently fish production, depend on these fluxes and are impacted by agricultural and silvicultural practices on the watershed. Numerous ponds dot the forestry landscape (e.g. Vosges, Woëvre, Brenne). For our team, it appears essential to anticipate future changes at forest catchment scale in order to determine functional changes in pond systems.

**Science and innovation issues:**

The impact of ponds on streams is poorly understood. Ponds are sometimes criticized for the disruption of ecological continuum they could induce. On the other hand, as we observed during our previous studies, ponds can improve water quality by retention of contaminants. The work carried out in the framework of the PISCEnLIT program (financed by the National Agency for Research), in which our team is currently involved, show a wide range of ecosystem services provided by these lentic systems. By assessing the response of ponds to changes on forest watersheds, we will determine whether the presence of ponds can improve the resilience of aquatic environments. Knowledge of trophic disturbances induced by these changes will also allow to predict the impacts on the uses of the pond (e.g., fishing, hunting, recreation), and other ecosystem services (e.g. water quality, biodiversity).

**Available equipment, plant material and methods:**

*Field equipments:*

Sampling materials (surber, Eckman Grab, boat, plankton nets), automatic water samplers, pH-meters, conductivity meters, oxygen meters, turbidity meters, water level recorders, multiparametric data loggers, fishpond (2 ha surface area).

*Laboratory equipments:*

30 independent water-recirculated tanks of 500L, 9 independent water-recirculated tanks of 1700L, 16 tanks of 3000L, hatchery, lyophilization units, centrifuges, spectrofluorimeter, PCR thermocycler, laminar flow hood, temperature-controlled incubator, platform for extraction of biomolecules, GCMS, HPLC, IRMS.

**Skills (cognitive and technical) that will be developed during the contract:**
This work will give to the researcher the opportunity to get to know with analytical and sampling methods on the field and in the laboratory (e.g. water, organism and litter sampling; determination of aquatic organisms; quantitative and qualitative monitoring of communities and of litter degradation, physico-chemical and isotopic analyses, implementation of experimentations in microcosms and mesocosms). The researcher will also develop skills of abstraction and synthesis necessary for the development of a dynamic model of degradation of organic matter in ponds. The candidate will develop skills in group work and will monitor the experiments conducted in collaboration with other universities presented above.

**Presentation of the research team (UR AFPA - Nancy - France):**
Composed by 32 professors, associated professors and researchers, 18 engineers, technicians and administrators (BIATOSS) and 20 Ph.D. students, the Research Unit on Animal and Functionality of Animal Products (UR AFPA, EA3998, USC INRA 340 with INRA departments PHASE “Physiologie Animale et Systèmes d’Elevage” and ALIMH “Alimentation Humaine”) belongs to the axis "Agronomy Agro-industry and Forestry (A2F)" of the University of Lorraine and contributes to the Lorraine pole of competence "FABELOR". UR AFPA is organized into four research teams (1- Domestication in inland aquaculture DAC; 2- Micropollutants and food contaminants MRCA; 3- Proteolysis and biofunctionalities of proteins and peptides PB2P, 4- Bioavailability and functionalities of dietary lipids BFLA). The present project concerns the team DAC which comprises 2 professors, 6 associated professors or researcher, 1 engineer, 2 technicians and 5 PhD students. Since 8 years, DAC develop a new research axis on the interactions between fish culture ponds and watershed management (contaminants flows), and the analysis of ecosystemic services associated to such agro-system.

**Supervising scientists of the PhD and the post-doctoral position:**
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